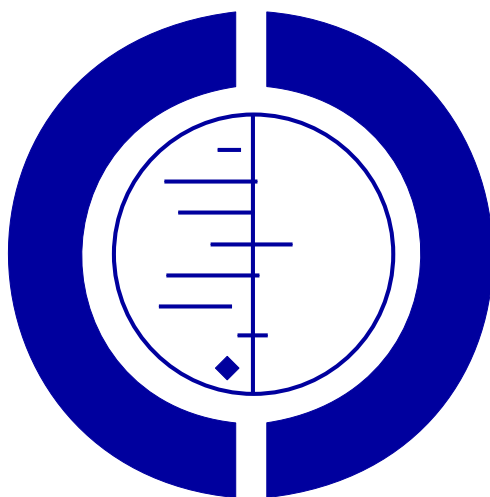


Continuous infusion versus intermittent flushing to prevent loss of function of peripheral intravenous catheters used for drug administration in newborn infants (Review)

Flint A, McIntosh D, Davies MW



**THE COCHRANE
COLLABORATION®**

This is a reprint of a Cochrane review, prepared and maintained by The Cochrane Collaboration and published in *The Cochrane Library* 2006, Issue 1

<http://www.thecochranelibrary.com>



TABLE OF CONTENTS

ABSTRACT	1
PLAIN LANGUAGE SUMMARY	2
BACKGROUND	2
OBJECTIVES	2
CRITERIA FOR CONSIDERING STUDIES FOR THIS REVIEW	3
SEARCH METHODS FOR IDENTIFICATION OF STUDIES	3
METHODS OF THE REVIEW	3
DESCRIPTION OF STUDIES	4
METHODOLOGICAL QUALITY	4
RESULTS	5
DISCUSSION	6
AUTHORS' CONCLUSIONS	7
POTENTIAL CONFLICT OF INTEREST	7
ACKNOWLEDGEMENTS	7
SOURCES OF SUPPORT	7
REFERENCES	8
TABLES	8
Characteristics of included studies	8
Characteristics of excluded studies	10
ANALYSES	10
Comparison 01. Continuous infusion versus intermittent flushing	10
COVER SHEET	10
GRAPHS AND OTHER TABLES	11
Analysis 01.01. Comparison 01 Continuous infusion versus intermittent flushing, Outcome 01 Duration of cannula patency for the first cannula used per infant (hours)	11
Analysis 01.02. Comparison 01 Continuous infusion versus intermittent flushing, Outcome 02 Number of cannulas used per infant in the first 48 hours	12

Continuous infusion versus intermittent flushing to prevent loss of function of peripheral intravenous catheters used for drug administration in newborn infants (Review)

Flint A, McIntosh D, Davies MW

This record should be cited as:

Flint A, McIntosh D, Davies MW. Continuous infusion versus intermittent flushing to prevent loss of function of peripheral intravenous catheters used for drug administration in newborn infants. *The Cochrane Database of Systematic Reviews* 2005, Issue 4. Art. No.: CD004593.pub2. DOI: 10.1002/14651858.CD004593.pub2.

This version first published online: 19 October 2005 in Issue 4, 2005.

Date of most recent substantive amendment: 12 July 2005

ABSTRACT

Background

The use of peripheral intravenous cannulae is common in newborn babies. Many of them require an intravenous line only for medications and not for fluid. Currently there is little uniformity in methods used to maintain cannula patency.

Objectives

The object of this review was to determine which method was better for maintaining intravenous lines used in neonates for intravenous medication only: intermittent flushing or continuous infusion

Search strategy

We searched The Cochrane Central Register of Controlled Trials (CENTRAL, The Cochrane Library, Issue 2, 2004), CINAHL (from 1982 to June 2004) and MEDLINE (from 1966 to June 2004) .

Selection criteria

Randomised controlled trials comparing continuous infusion to intermittent flushing to maintain patency of intravenous cannulas. Units of randomisation might include individual catheters or individual babies.

Data collection and analysis

Three reviewers independently assessed trial quality and extracted data.

Main results

Two studies were eligible for inclusion. In one study only one of our primary outcomes was available: the duration of cannula patency for the first cannula used per infant was slightly longer in the continuous infusion group, but not significantly so, with a mean difference of -4.3 hours (95% CI -18.2 to 9.7).

In the second study, only one of our primary outcomes was available: the mean (SD) number cannulas used per infant in the first 48 hours was less in the intermittent flush group with a mean difference of -0.76 cannulas (95% CI -1.37 to -0.15). No results were available for any of our other primary outcomes: in the published report, results were reported per catheter rather than per infant, a number of infants received more than one intravenous catheter (39 infants received an unknown number of catheters). The overall duration of cannula patency was significantly longer in the intermittent flush group with a mean duration of patency in the intermittent flush group of 2.1 days (SD 1.0) compared with the continuous infusion group where the mean duration of patency was 1.0 days (SD 0.5) - Student's t test P value 0.0003.

Authors' conclusions

It is difficult to draw reliable conclusions given the way the data were analysed and reported in the two included studies. The reliability of the results is uncertain. However, given the caution in interpreting these data, it should also be noted that the use of intermittent

flushes was not associated in either study with a decreased cannula life or any other disadvantages, thus lending some support for the use of intermittent flushing of cannulas in a selected population in neonatal nurseries.

PLAIN LANGUAGE SUMMARY

The best way to keep a newborn baby's intravenous line working is still unknown.

We aimed to find out which was the better way to keep a newborn baby's intravenous line open and working -- either running a continuous amount of intravenous fluid through it (continuous infusion) or giving a small amount of fluid through it every few hours (intermittent flush) only. One study showed no difference between the two approaches for keeping a baby's intravenous line open and working and one study showed an advantage for intermittent flushes. The studies, however, had some problems in how the data were analysed and reported. Therefore, we are uncertain as to how reliable the results are and further research should be undertaken.

BACKGROUND

Peripheral intravenous cannula use is common in newborn babies admitted to neonatal nurseries (Ward 1993). A significant number of these babies only require intermittent intravenous drug therapy and do not require supplemental fluids or other continuous drug infusions. Intravenous cannulation and therapy may require the baby to be separated from its mother, at least initially, and can delay the establishment of maternal infant bonding (Malcolm 2000; WHO 1998).

Insertion of peripheral intravenous cannulas in neonates can be a stressful experience for the baby, the new parent and the medical/nursing staff (Yeo 1998; Olds 2000; Cotton 1998). It is therefore desirable once the intravenous cannula is inserted that its patency be maintained for as long as possible. Each cannula should last as long as possible and for any given period of treatment a minimum number of cannulas should be used. To achieve this the cannula can be infused continuously with fluid at a low rate or flushed intermittently (usually every 4-8 hours) (Cotton 1998).

Continuous infusions require more nursing time and equipment and impede access of the mother to the infant but the cannula might last longer and have fewer complications such as extravasation or dislodgment. Intermittent flushing would decrease nursing time and equipment and allow greater access of the mother to her infant, but may decrease cannula life by blockage due to clotting. Currently there is little uniformity between neonatal nurseries as to which method is used and evidence is required to decide which method, if any, best maintains intravenous access.

There is limited evidence that the following factors may increase the risk of intravenous cannula failure: certain drugs (such as gentamicin or aminophylline) (Mocclair 1995); size of cannula (Danek 1992).

A different question as to whether the continuous infusion fluid or the intermittent flush solution should contain heparin has been considered in a separate Cochrane review (Shah 2004). Shah et

al concluded that "no conclusive evidence is available...to evaluate the effectiveness of heparin to prolong PIV [peripheral intravenous] cannula life in the neonatal population". Only eight eligible studies were identified and only five commented on duration of catheter use. Due to significant clinical heterogeneity and heterogeneity in treatment effect no recommendation could be made as to whether use of heparin was advisable or not without further research.

As with all invasive procedures, there is a significant risk of introducing infection into the newborn when inserting a peripheral intravenous catheter. Septicaemia, although an infrequent complication could potentially have a lethal outcome. It is therefore desirable that catheter patency be maintained as long as possible thus reducing the number of skin breakages made in the baby and ultimately decreasing the risk of infection.

OBJECTIVES

Primary Objectives

- To determine whether continuous infusion or intermittent flushing is better with regard to maintaining patency of intravenous cannulas.

Secondary Objectives

- To determine which method resulted in fewer complications (infection, dislodgment, extravasation, phlebitis).
- To determine which method has the greater cost.
- To determine which method is better for reducing the time to initiate and attain full suck feeding.

We also aim to determine if the outcomes above were different by:

- Which drug is being administered (antibiotics versus non antibiotics, aminoglycosides versus non aminoglycosides)

- The size of the cannula used for intravenous therapy (24G or smaller versus 22G or bigger)

CRITERIA FOR CONSIDERING STUDIES FOR THIS REVIEW

Types of studies

Only randomised controlled trials of adequate quality in which continuous infusion is compared to intermittent flushing to maintain patency of intravenous cannulas in neonates will be included. Quasi randomised studies will not be used. Units of randomisation might include individual catheters or individual babies.

Types of participants

Newborn infants receiving intermittent intravenous drug treatment but not for continuous drug infusions or supplemental fluids.

Newborn infants are: term infants < 29 days old, preterm infants up to a corrected age of 44 weeks, or infants cared for in a neonatal unit.

Types of intervention

Continuous infusion of peripheral intravenous catheters with dextrose and/or saline solutions, with or without heparin.

Intermittent flushes of peripheral intravenous catheters with saline or heparinised saline given at intervals greater than every second hour.

Studies which allow the use of peripheral intravenous catheters for blood sampling will not be included.

Types of outcome measures

Primary Outcomes

- Duration of cannula patency (hours) for the first cannula used per infant
- Number of cannulas used during primary treatment course in individual infants
- Number of cannulas used during first 48 hours in individual infants

Secondary Outcomes

- Duration of cannula patency (hours) in individual infants (for all cannulas as averaged during the treatment course or during the first 24, 48, 72 hours of treatment)
- Proportion of infants with loss of cannula function
 - blockage
 - extravasation
 - phlebitis
 - dislodgment
 - infection

- Cost (dollars)
- Mortality (at discharge, 28 days or one year)
- Proportion of infants with delayed suck feeding (defined as either i. has not initiated suck feeding within 12 hours of birth, ii. requires supplemental nasogastric tube feeding)
- Proportion of infants not breast feeding (at discharge, 28 days, three months or six months)
- Infections (positive blood cultures or as defined in individual studies)
- Maternal-infant bonding (however defined in individual studies)

SEARCH METHODS FOR IDENTIFICATION OF STUDIES

See: Neonatal Group methods used in reviews.

The standard search strategy for the Cochrane Neonatal Review Group was used. See: Neonatal Review Group search strategy. We searched the following electronic databases: The Cochrane Central Register of Controlled Trials (CENTRAL, The Cochrane Library, Issue 2, 2004), CINAHL (from 1982 - June 2004) and MEDLINE (from 1966 - June 2004).

Searches of the electronic databases were based on the following search terms:

MeSH terms: infusions, intravenous OR injections, intravenous; OR text words: "IV treatment" OR "IV therapy" OR "IV drug" OR "IV medication" OR "intravenous treatment" OR "intravenous therapy" OR "intravenous drug" OR "intravenous medication" OR "intra-venous treatment" OR "intra-venous therapy" OR "intra-venous drug" OR "intra-venous medication"; NOT MeSH term: Substance Abuse, Intravenous.

AND

MeSH term: infant, newborn OR text word "neonate"

AND

The highly sensitive search strategy developed by Kay Dickersin to identify RCTs (Dickersin 1994)

We also searched previous reviews including cross references. We also used the results of searches of abstracts, conference and symposia proceedings as done by the Cochrane Neonatal Review Group. No language restrictions were applied. Published or unpublished data were considered.

METHODS OF THE REVIEW

Criteria and methods used to assess the methodological quality of the trials: standard methods of the Cochrane Collaboration and

its Neonatal Review Group were used. At least two of the reviewers worked independently to search for and assess trials for inclusion and methodological quality. Studies were assessed using the following key criteria: allocation concealment (blinding of randomisation), blinding of intervention, completeness of follow up and blinding of outcome measurement. The reviewers extracted data independently. Differences were resolved by discussion. An attempt was made to contact study investigators for additional information or data.

Data analysis:

For individual trials: for continuous variables such as duration of cannula patency, mean differences, and 95% confidence intervals were to be reported. For categorical outcomes such as mortality, the relative risks (RR) and 95% confidence intervals will be reported.

For pooled results: for continuous variables, weighted mean differences (WMD) and 95% confidence intervals will be reported. For categorical outcomes, the relative risks (RR) and 95% confidence intervals will be reported. For significant findings, the risk difference (RD) and number needed to treat (NNT) will also be reported. Each treatment effect will be tested for heterogeneity to help determine suitability for pooling of results in a meta-analysis. The fixed effects model will be used for meta-analysis.

DESCRIPTION OF STUDIES

Two studies were identified for inclusion in this review (Kalyn 2000; Taylor 1989). Methods and clinical details including participants, interventions and outcomes are given in Table 1.

Included studies

Kalyn et al (Kalyn 2000) performed a multi-centre randomised controlled trial. Infants were randomised either to a continuous infusion of 0.5-1 mL/hr of 10% Dextrose or intermittent flushes with 0.5-1 mL every 6 hrs of 0.9% non heparinised saline. The infants were randomly assigned to their groups using a computer generated random number. Blinding of the interventions was obviously not done. Infants receiving intermittent drug therapies via a peripheral intravenous catheter were eligible for inclusion in the study but infants receiving continuous drug infusions or supplemental fluids were not. A total of 95 neonates (42 to intermittent flush group and 53 to continuous infusion group) were cannulated with 238 catheters (84 to intermittent flush group and 154 to the continuous infusion group) during the study period. The primary diagnosis for all the infants was sepsis. Follow-up continued until the intravenous catheter was either removed because intravenous medication was stopped or the catheter was no longer working; the infant was transferred elsewhere; or the infant required maintenance intravenous fluids. The two groups were all well matched for demographic and clinical variables, including birth weight, gestational age, the site and size of the catheters and types of drugs being administered. The duration of patency of each catheter was

recorded as well as the reasons for loss of patency: phlebitis, occlusion, leaking and infiltration. The outcomes were reported per catheter used.

Taylor et al (Taylor 1989) did a randomised controlled trial in infants who were admitted to the 'intermediate care' nursery who either:

1. required intravenous medications but no additional intravenous fluids, or
2. had an umbilical arterial catheter in situ and required an intravenous cannula for medications.

The infants were randomised either to a continuous infusion group where the intravenous line was kept patent by a continuous infusion of 10% dextrose (without heparin) at a rate of 1.5 to 3.0 ml/hr; or intermittent flushes where the intravenous cannula was kept patent with a heparin lock (0.5 ml of heparinised saline) given every six hours or after injection of medications. The method of randomisation was not stated. Blinding of the interventions was obviously not done. One infant in the intermittent flush group was excluded post randomisation because the "... catheter was needed only briefly, not allowing for time for data collection". Data were collected on a total of 39 neonates (22 to intermittent flush group and 17 to continuous infusion group) who were cannulated with an unknown number of catheters. The infants were enrolled in the study until they no longer required intravenous access. The two groups were all well matched for demographic and clinical variables, including birth weight and gestational age. Outcome measures included the number of days the infant was enrolled in the study; quantitation of parental medications, blood products and intravenous fluids; number of line infiltrations; duration of cannula patency (this seemed to have been measured for each cannula regardless of the number used in each infant); and the number of times the infant was removed from the incubator to be held by a nurse or parent.

Excluded Studies

A number of studies were found which examined the duration of peripheral intravenous catheter patency with or without heparin intermittent flushes (Danek 1992; Hanrahan 2000; LeDuc 1997; McMullen 1993; Nelson 1998). However, none compared intermittent flushes with continuous infusions and were therefore not included in the review. This is the subject of another review by Shah et al (Shah 2004).

METHODOLOGICAL QUALITY

Kalyn's study (Kalyn 2000): the randomisation method was by a computer generated random number to assign infants by alternate sequential series; allocation was performed in a blind manner by using sealed opaque envelopes to assign each infant to either group; blinding of intervention was not done; follow-up was complete and outcome assessments were not blinded.

Taylor's study (Taylor 1989): the randomisation method was not stated; allocation was performed in a blind manner by using sealed opaque envelopes to assign each infant to either group; blinding of intervention was not done; follow-up was complete and outcome assessments were not blinded.

RESULTS

Two studies (Kalyn 2000; Taylor 1989) were eligible for inclusion.

Kalyn 2000

The lead author of Kalyn et al (Kalyn 2000) was contacted for further information regarding this study: additional data were available on the duration of patency for the first catheter used per infant.

Primary outcomes

- Duration of cannula patency for the first cannula used per infant was slightly longer in the continuous infusion group, but not significantly so, with a mean difference of -4.3 hours (95% CI -18.2 to 9.7). These unpublished data were provided by the lead author of the study (Kalyn 2000).
- Number of cannulas used during primary treatment course in individual infants - individual outcome not available
- Number of cannulas used during the first 48 hrs in individual infants - individual outcome not available

Secondary outcomes

- Duration of cannula patency in individual infants for all catheters as averaged during the treatment course:

In the published report (Kalyn 2000) results were reported per catheter rather than per infant, a number of infants received more than one intravenous catheter (95 infants received 238 catheters in total). No statistically significant difference was found between the two groups for duration of cannula patency. The mean duration of patency in the intermittent flush group was 45.2 hours (SD 29.3) and in the continuous infusion group 48.7 hours (SD 41.1) - Mann-Whitney U test P value 0.13. However, whilst the mean duration of cannula patency in each group was similar, there were 84 cannulas used in the intermittent flush group and 154 cannulas used in the continuous infusion group. It is difficult to reconcile that mean duration of cannula use was not different; yet almost twice as many cannulas were used in the continuous infusion group. The average total duration of cannula use for infants in the continuous infusion group must have been longer (although data for this are not available). And therefore any differences between the two groups is prone to significant bias.

- Duration of cannula patency (hours) in individual infants for all cannulas as averaged during the first 24 hours of treatment - the study did not report on this outcome

- Duration of cannula patency (hours) in individual infants for all cannulas as averaged during the first 48 hours of treatment - the study did not report on this outcome
- Duration of cannula patency (hours) in individual infants for all cannulas as averaged during the first 72 hours of treatment - the study did not report on this outcome
- Proportion of infants with loss of cannula function due to:

-blockage - individual outcome not available
 -extravasation - individual outcome not available
 -phlebitis - individual outcome not available
 -dislodgment - individual outcome not available
 -infection - individual outcome not available

A significant difference (Chi squared test $P < 0.001$) was found when the two catheter groups were compared with respect to the removal or loss of patency of catheters. The results were presented by catheter rather than by infant although it was stated that results were also analysed by infant and similar results were obtained. The catheters in the intermittent flush group were less likely to infiltrate, leak or cause phlebitis (35.7%) than in the continuous infusion group. The continuous infusion group, however, were less likely to occlude (9.1%) than the intermittent flush group (25%). In the intermittent flush group 39% of catheters (compared with 24% in the continuous infusion group) did not have infiltration/phlebitis/leaking/occlusion because the catheter was either removed because intravenous medication was stopped, the infant was transferred elsewhere or the infant required maintenance intravenous fluids.

- Cost (dollars) - individual outcome not available
- Mortality - individual outcome not available
- Proportion of infants with delayed suck feeding - individual outcome not available
- Infections - individual outcome not available
- Maternal - infant bonding-individual outcome not available

Taylor 1989

The lead author of Taylor et al (Taylor 1989) was contacted for further information regarding this study: additional data were available on post-randomisation exclusions, the number of cannulas used during the first 48 hours in individual infants, and loss of cannula function.

Primary outcomes

- Duration of cannula patency for the first cannula - individual outcome not available
- Number of cannulas used during primary treatment course in individual infants - individual outcome not available
- Number of cannulas used during the first 48 hrs in individual infants:

The mean (SD) number cannulas used per infant in the first 48 hours was 1.59 (0.59) in the intermittent flush group and 2.35 (1.17) in the continuous infusion group. The mean difference was -0.76 cannulas (95% CI -1.37 to -0.15).

Secondary outcomes

- Duration of cannula patency in individual infants for all catheters as averaged during the treatment course:

In the published report (Taylor 1989) results were reported per catheter rather than per infant, a number of infants received more than one intravenous catheter (39 infants received an unknown number of catheters). The duration of cannula patency was significantly longer in the intermittent flush group. The mean duration of patency in the intermittent flush group was 2.1 days (SD 1.0) and in the continuous infusion group 1.0 days (SD 0.5) - Student's t test P value 0.0003.

- Duration of cannula patency (hours) in individual infants for all cannulas as averaged during the first 24 hours of treatment - the study did not report on this outcome
- Duration of cannula patency (hours) in individual infants for all cannulas as averaged during the first 48 hours of treatment - the study did not report on this outcome
- Duration of cannula patency (hours) in individual infants for all cannulas as averaged during the first 72 hours of treatment - the study did not report on this outcome
- Proportion of infants with loss of cannula function due to:

-blockage - outcome not available

-extravasation - outcome not available except for first 48 hours (see below)

-phlebitis - nil noted in either group

-dislodgment - outcome not available except for first 48 hours (see below)

-infection - nil noted in either group

The authors reported extravasation (i.e., subcutaneous infiltration) as the number of infiltrations per day. There was a mean (SD) of 0.7 (0.6) infiltrations per day in the continuous infusion group and 0.3 (0.2) in the intermittent flush group (Student's t test P value 0.0015).

- Cost (dollars) - individual outcome not available
- Mortality - individual outcome not available
- Proportion of infants with delayed suck feeding - individual outcome not available
- Infections - individual outcome not available
- Maternal - infant bonding-individual outcome not available

The study also reported the following outcomes:

- volume of fluid infused through the cannula - mean (SD) of 28.7 (11) ml/kg/day in the continuous infusion group and 7.7 (6.8) ml/kg/day in the intermittent flush group (Student's t test P <0.0001);
- number of times the infant was removed from the incubator by parent or nurse - mean (SD) of 1.9 (1.3) times per day in the continuous infusion group and 1.2 (1.5) times per day in the intermittent flush group (Student's t test P value 0.2);
- a score consisting of a "subjective evaluation regarding ease of handling and maintaining intravenous patency" (a scale of 1 to 5 with 1 having maximum ease of handling and maintaining intravenous patency and 5 having maximum problems with ease of handling and maintaining intravenous patency) - mean (SD) score of 3.8 (1.1) in the continuous infusion group and 1.7 (0.7) in the intermittent flush group (Student's t test P value 0.0001).

Extra information available from the study investigators also include the following outcomes:

- need for the cannula to be replaced during the entire study period - 2/17 (12%) infants did not need their cannula to be replaced in the continuous infusion group, and 8/22 (36%) infants did not need their cannula replaced in the intermittent flush group;
- loss of cannula function in the first 48 hours - in the continuous infusion group 10 cannulas extravasated, two dislodged, five remained intact; in the intermittent flush group 11 cannulas extravasated, one dislodged, 10 remained intact.

DISCUSSION

Even though one study showed no difference between the approaches for maintaining cannula patency and one showed an advantage for intermittent flushes, it is unfortunate that the way the data were analysed and reported in the two included studies makes the reliability of the results uncertain.

The reports (for both included studies) only included as their main outcome the average duration of cannula patency for all cannulas. That is, they reported duration of cannula patency for all cannulas in all infants in each treatment group averaged over the treatment course. Some infants would have had multiple cannulas and, therefore, the mean duration of cannula patency would include multiple measures of the duration of cannula patency in some infants with non-independence of those multiple measures. This would invalidate the assumptions necessary to ensure the reliability of the statistical tests used.

In the study by Kalyn et al (Kalyn 2000) the number of catheters per number of neonates was difficult to interpret and additional unpublished data are not available to clarify this. The reasons for

re-cannulation of individual infants were not recorded in the study. However, the additional information that was provided by the study investigators for duration of patency for the first catheter used per infant did not show any significant difference between groups for this outcome.

Taylor et al found a longer duration of cannula patency (averaged over all catheters for that infant) with intermittent flushing and greater ease of handling of those infants. They also found that the mean number of cannulas used per infant in the first 48 hours was less for intermittent flushing. We had speculated that a baby requiring intermittent flushing of their intravenous line is far more portable than one with a continuous infusion line. We believed that this would make handling, feeding and caring for baby easier for mothers in neonatal nurseries and enable staff the opportunity to enhance maternal-infant bonding opportunities. These outcomes were assessed by Taylor et al (Taylor 1989) using a subjective nursing score (unblinded assessment) and they did find that the infants having intermittent flushes were easier to care for.

It should be noted that Taylor et al's study compared intermittent flushing of the cannula with heparinised saline with a continuous infusion that did not contain heparin. The use of heparinised saline for the intermittent flush used to maintain cannula patency has been reviewed by Shah et al (Shah 2004). Their systematic review found five studies that compared intermittent flush with heparin and intermittent flush without heparin and reported the outcome of duration of cannula patency for the first cannula used per infant. There was no consistency of results for this outcome with two studies showing longer duration with heparin, one study showing longer duration without heparin and two studies showing no difference.

AUTHORS' CONCLUSIONS

Implications for practice

It is difficult to draw reliable conclusions given the way the data were analysed and reported in the two included studies. The reliability of the results is uncertain. However, given the caution in interpreting these data, it should also be noted that the use

of intermittent flushes was not associated in either study with a decreased cannula life or any other disadvantages, thus lending some support for the use of intermittent flushing of cannulas in a selected population in neonatal nurseries.

Implications for research

Further research is required to examine the duration of cannula patency comparing the two methods. Outcome assessment and data analysis should be reported by infant and by cannula (especially the first cannula used in each infant). Cost analysis would also be valuable comparing the cost of continuous infusions to intermittent flushing. Other outcomes that might enhance the interaction between mothers, babies and nursing staff would also be worthwhile, such as maternal satisfaction and ease of handling for mothers and nurses.

POTENTIAL CONFLICT OF INTEREST

Nil

ACKNOWLEDGEMENTS

Thank you to Angela Kalyn for providing some additional data from her study (Kalyn 2000), and to Howard Kilbride for providing some additional data from his study (Taylor 1989).

SOURCES OF SUPPORT

External sources of support

- Cochrane Perinatal Team, Brisbane AUSTRALIA

Internal sources of support

- Grantley Stable Neonatal Unit, Royal Women's Hospital, Brisbane AUSTRALIA
- Dept of Paediatrics and Child Health, University of Queensland, Brisbane AUSTRALIA
- Simpson Centre for Reproductive Health UK

REFERENCES

References to studies included in this review

Kalyn 2000 *[published data only]*

Kalyn A, Blatz S, J Pinelli. A comparison of continuous infusion and intermittent flushing methods in peripheral intravenous catheters in neonates. *Journal of IV Nursing* 2000;**23**:146–53.

Taylor 1989 *[published data only]*

Taylor J, Shannon R, Kilbride HW. Heparin lock intravenous line: use in newborn infants. *Clinical Pediatrics* 1989;**28**:237–40.

References to studies excluded from this review

Danek 1992

Danek GD, Noris EM. Pediatric i.v. catheters: efficacy of saline flush. *Pediatric Nursing* 1992;**18**:111–3.

Hanrahan 2000

Hanrahan KS, Kleiber C, Berends S. Saline for peripheral intravenous locks in neonates: evaluating change in practice. *Neonatal Network* 2000;**19**:19–24.

LeDuc 1997

LeDuc K. Efficacy of normal saline solution versus heparin solution for maintaining patency of peripheral intravenous catheters in children. *Journal of Emergency Nursing* 1997;**23**:306–9.

McMullen 1993

McMullen A, Fioravanti ID, Pollack V, Rideout K, Sciera M. Heparinized saline or normal saline as a flush solution in intermittent intravenous lines in infants and children. *MCN. The American Journal of Maternal Child Nursing* 1993;**18**:78–85.

Nelson 1998

Nelson JJ, Graves SM. 0.9% Sodium chloride injection with and without heparin for maintaining peripheral indwelling intermittent-infusion devices in infants. *American Journal of Health-System Pharmacy* 1998;**55**:570–3.

Additional references

Cotton 1998

Cotton MC, Turner BS, Miller-Bell M. Pharmacology in neonatal care. In: Merenstein GB, Gardener SL, editor(s). *Handbook of Intensive Care*. 5th Edition. St Louis: Mosby, 1998:148–62.

Danek 1992

Danek GD, Noris EM. Pediatric i.v. catheters: efficacy of saline flush. *Pediatric Nursing* 1992;**18**:111–3.

Dickersin 1994

Dickersin K, Scherer R, Lefebvre C. Identifying relevant studies for systematic reviews. *British Medical Journal* 1994;**309**:1286–91.

Malcolm 2000

Malcom IL, Tudehope DI, Thearle MJ. Parent-infant attachment and support for parents experiencing perinatal loss. In: Malcom IL, Tudehope DI, Thearle MJ, editor(s). *Essentials of neonatal medicine*. 3rd Edition. Oxford: Blackwell Science, 2000:297–303.

Mocclair 1995

Mocclair A, Bates I. The efficacy of heparin in maintaining peripheral infusions in neonates. *European Journal of Pediatrics* 1995;**154**:567–70.

Olds 2000

Olds SB, London ML, Wieland Ladewig PA. The newborn at risk: conditions present at birth. In: Olds SB, London ML, Wieland Ladewig PA, editor(s). *Maternal-newborn nursing: a family and community-based approach*. 6th Edition. New Jersey: Prentice Hall Health, 2000:804–903.

Shah 2004

Shah PS, Ng E, Sinha AK. Heparin for prolonging peripheral intravenous catheter use in neonates. In: *The Cochrane Database of Systematic Reviews*, 3, 2004.

Ward 1993

Ward R M. Neonatal pharmacology. In: Kenner C, Brueggemeyer A, Gunderson LP, editor(s). *Comprehensive neonatal nursing*. 1st Edition. Philadelphia: W.B.Saunders Company, 1993:926–939.

WHO 1998

Anonymous. *Evidence for the ten steps to successful breastfeeding*. Revised Edition. Geneva: World Health Organisation, 1998.

Yeo 1998

Yeo H. Stress in the neonatal unit. In: Yeo H, editor(s). *Nursing the Neonate*. Oxford: Blackwell Science, 1998:278–92.

**Indicates the major publication for the study*

TABLES

Characteristics of included studies

Study	Kalyn 2000
Methods	Multi-centre randomised controlled trial with treatment group allocation determined by computer generated randomisation.
	Assessment of the following key criteria: allocation concealment (blinding of randomisation) - yes, group allocation was concealed by opaque envelopes;

Characteristics of included studies (Continued)

	blinding of intervention - no; completeness of follow up - all infants that entered the study were accounted for; blinding of outcome measurement - no.
Participants	Neonates in the neonatal nursery who do not require IV fluids. Number of infants = 95 -IF=42 -CI=53 Number of catheters = 238 - 154 in CI - 84 in IF
Interventions	Continuous infusion (CI) using 0.5-1 mL of 10% Dextrose; or intermittent flushing (IF) using 0.5-1 mL 0.9% normal saline flushed before and after every medication and every 6 hours.
Outcomes	Proportion of catheters with: 1. infiltration, phlebitis or leaking; 2. occlusion; 3. either removal because intravenous medication was stopped, the infant was transferred elsewhere or the infant required maintenance intravenous fluids.
Notes	The infants were randomised and allocated to either group, but the data were analysed and reported by catheter. The lead author of this study was contacted for further information regarding this study: additional data were available on the duration of patency for the first catheter used per infant.
Allocation concealment	A

Study	Taylor 1989
Methods	Randomised controlled trial. The randomisation method was not stated. Assessment of the following key criteria: allocation concealment (blinding of randomisation) - yes, group allocation was concealed by opaque envelopes; blinding of intervention - no; completeness of follow up - all infants that entered the study were accounted for; blinding of outcome measurement - no.
Participants	Newborn infants who were admitted to the 'intermediate care' nursery who either 1. required intravenous medications but no additional intravenous fluids, or 2. had an umbilical arterial catheter in situ and required an intravenous cannula for medications. Number of infants = 39 -IF=22 -CI=17
Interventions	Continuous infusion (CI) using 10% dextrose (without heparin) at a rate of 1.5 to 3.0 ml/hr; or intermittent flushing (IF) using a heparin lock (0.5 ml of heparinised saline) given every 6 hours or after injection of medications.
Outcomes	Outcome measures included: the number of days the infant was enrolled in the study; quantitation of parental medications, blood products and intravenous fluids; number of line infiltrations;

Characteristics of included studies (Continued)

duration of cannula patency (this seemed to have been measured for each cannula regardless of the number used in each infant); and
the number of times the infant was removed from the incubator to be held by a nurse or parent.

Notes

Allocation concealment A

Abbreviations

CI-continuous infusion

IE-intermittent infusion

Characteristics of excluded studies

Danek 1992 Did not compare continuous infusion with intermittent flushes.

Hanrahan 2000 Historical cohort comparison only; did not compare continuous infusion with intermittent flushes.

LeDuc 1997 Did not compare continuous infusion with intermittent flushes.

McMullen 1993 Did not compare continuous infusion with intermittent flushes.

Nelson 1998 Did not compare continuous infusion with intermittent flushes.

ANALYSES

Comparison 01. Continuous infusion versus intermittent flushing

Outcome title	No. of studies	No. of participants	Statistical method	Effect size
01 Duration of cannula patency for the first cannula used per infant (hours)			Weighted Mean Difference (Fixed) 95% CI	Totals not selected
02 Number of cannulas used per infant in the first 48 hours			Weighted Mean Difference (Fixed) 95% CI	Totals not selected

COVER SHEET

Title	Continuous infusion versus intermittent flushing to prevent loss of function of peripheral intravenous catheters used for drug administration in newborn infants
Authors	Flint A, McIntosh D, Davies MW
Contribution of author(s)	ALF - searched for studies, judged eligibility of reports identified in the searches, extracted data from the eligible study, assessed methodological quality of the eligible study, co-wrote review. DM - searched for studies, judged eligibility of reports identified in the searches, co-wrote review. MWD - searched for studies, judged eligibility of reports identified in the searches, extracted data from the eligible study, assessed methodological quality of the eligible study, revised review.
Issue protocol first published	2004/1
Review first published	2005/4
Date of most recent amendment	23 August 2005
Date of most recent SUBSTANTIVE amendment	12 July 2005

What's New	Information not supplied by author
Date new studies sought but none found	Information not supplied by author
Date new studies found but not yet included/excluded	Information not supplied by author
Date new studies found and included/excluded	Information not supplied by author
Date authors' conclusions section amended	Information not supplied by author
Contact address	Dr Diana McIntosh Paediatric Registrar Neonatal Unit Simpson Centre for Reproductive Health Edinburgh UK E-mail: mcintosh_diana@hotmail.com Tel: 00441416442131
DOI	10.1002/14651858.CD004593.pub2
Cochrane Library number	CD004593
Editorial group	Cochrane Neonatal Group
Editorial group code	HM-NEONATAL

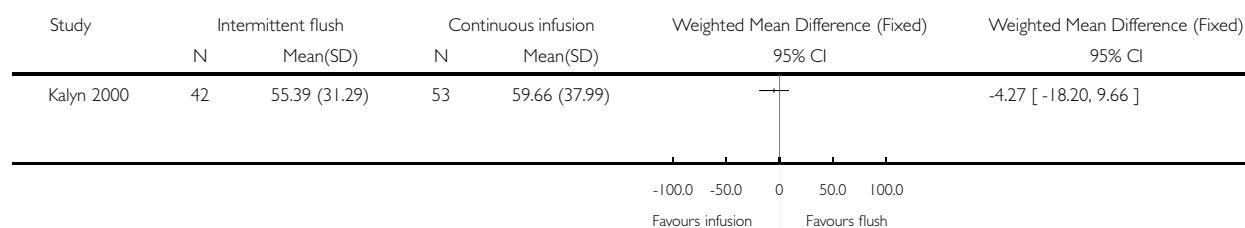
GRAPHS AND OTHER TABLES

Analysis 01.01. Comparison 01 Continuous infusion versus intermittent flushing, Outcome 01 Duration of cannula patency for the first cannula used per infant (hours)

Review: Continuous infusion versus intermittent flushing to prevent loss of function of peripheral intravenous catheters used for drug administration in newborn infants

Comparison: 01 Continuous infusion versus intermittent flushing

Outcome: 01 Duration of cannula patency for the first cannula used per infant (hours)



Analysis 01.02. Comparison 01 Continuous infusion versus intermittent flushing, Outcome 02 Number of cannulas used per infant in the first 48 hours

Review: Continuous infusion versus intermittent flushing to prevent loss of function of peripheral intravenous catheters used for drug administration in newborn infants

Comparison: 01 Continuous infusion versus intermittent flushing

Outcome: 02 Number of cannulas used per infant in the first 48 hours

